SOIL SURVEY OF THE NASHUA AREA, NEW HAMPSHIRE.

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DESCRIPTION OF THE AREA.

The Nashua area comprises a part of Hillsboro County, the middle one of the three counties bordering on the Massachusetts line. The area is covered by topographic sheets of the United States Geological Survey, and these were used as a base map upon which to plot the soils. The area surveyed, which comprises 312,320 acres, or 488 square miles, extends from the eastern boundary of Hillsboro County north from the Massachusetts line to parallel 43° north latitude, a distance of approximately 21 miles, and west to an arbitrary line, meridian 71° 50′ west longitude.

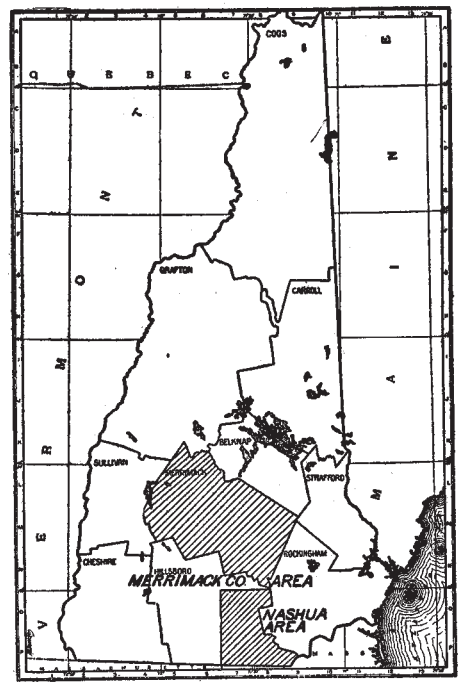

FIG. 2.—Sketch map showing location of the Nashua area, New Hampshire.

The area is rectangular, except for the eastern boundary, which is very irregular, following the town boundaries, which also form the Rockingham County and Middlesex County (Mass.) lines. The survey covers all or a part of twenty-two towns (townships). The towns wholly covered are Pelham, Hudson, Litchfield, Nashua, Merrimack, Bedford, Amherst, Milford, Hollis, Mason, Brookline, Wilton, and Mount Vernon; those only partly surveyed are Manchester, Goffstown, New Boston, Francestown, Greenville, Lyndeboro, Temple, and New Ipswich.

The Nashua area has a diversified topography, consisting of two principal divisions—hilly to mountainous uplands and broad trough-like valleys marked by their terraces and sand plains. The general relief of the area is the combined result of the work of preglacial erosion, subsequent glaciation, and postglacial erosion.

The Merrimac River has a broad, troughlike valley which extends north and south through the eastern part of the area. The valley is marked by a series of more or less distinct terraces, rising on both sides, one above another, to an elevation of 200 feet above the river, where they merge into the upland slopes. As the river is still cutting its channel deeper, no extensive flood plains are being formed, though rather high first bottoms, locally called "intervales," occur as a continuous narrow belt between Nashua and Reeds Ferry. These are undulating rather than flat, and in places are composed of a series of low narrow benches and terraces, the elevation above the river ranging from 10 to 20 or even 40 feet. They are not subject to annual overflow, except in the highest flood stages, when water backs into the troughs of the undulations. The next terraces are generally narrow though distinct, except the higher parts on the east bank, which have been practically obliterated by erosion and the piling up of the sands by the winds, resulting in a sloping to knolly or even hilly surface. The elevation of the Merrimac where it leaves the area is about 90 feet above mean sea level, and there are no marked changes in elevation until the lower rapids of Amoskeag Falls are reached at the northern boundary of the survey. The streams entering the Merrimac and the smaller streams of the area do not show the distinct terraces that characterize the Merrimac Valley, but are bordered by broad flat sand plains and low gravelly hummocky knolls or hills, the gravelly areas generally occurring along the brooks or smaller streams. The sand plains are usually found in broader parts of the valleys. The most extensive sand plain area is that lying along the Merrimac, between the mouths of the Nashua and Souhegan rivers. It extends some distance up the Nashua River and also northwest to the Souhegan at Ponemah. The area is very irregular in shape and is interrupted north of Nashua by disconnected gravelly or rocky knolls and hills. The area evidently represents either a glacial lake bed or an ancient stream delta.

The uplands consist of a series of hills and ridges, in part of mountainous character, whose general direction is parallel to the Merrimac Valley. From the Merrimac they rise gently on both sides, on the eastern side to elevations of 300 to 500 feet. On the western side they gradually become higher and more mountainous to the west and north, the crests reaching elevations of 1,000 to 1,200 feet, with higher points on some disconnected mountains like Lyndeboro, Piscataquog, and Uncanoonuc mountains, the Lyndeboro being 1,626 feet above sea level and the highest point within the area surveyed. All this region was subjected to glaciation, which not only scoured off the hills and filled in valleys, but finally left a heterogeneous mass of glacial till on the hills and large numbers of erratic glacial bowlders scattered over the surface. Rock ledges were also exposed.

Though the contours of the hills were in part smoothed by glaciation, as a whole the surface may be best described as rough. Lenticular or drumlinoid-shaped hills are common, and these represent largely the areas that have been cleared and cultivated. The ravines, especially in their upper parts, are steep and exceedingly stony. The varied surface of hills and valleys, partly in forest and partly cultivated, together with the large number of ponds and lakes, results in a pleasing and attractive landscape.

The Nashua area lies wholly in the drainage basin of the Merrimac River and is drained directly by that river and its tributaries. The Merrimac passes through the area from north to south near the eastern boundary. On the east the streams are small, the most important being Cohas Brook, in Manchester, which is the outlet of Massabesic Lake, this lake being the source of water supply for the city of Manchester. Beaver Brook drains the southeastern part, flowing through Pelham into Massachusetts and reaching the Merrimac near Lowell, in that State. The important tributaries of the Merrimac which enter on the west side are the Nashua, Souhegan, and Piscataquog rivers and Pennichuck Brook. The Nashua River drains the southern part of the area, having its source in Massachusetts and flowing in a general northeasterly direction, empties into the Merrimac at the city of Nashua. The Souhegan drains the central and larger part of the area. The Piscataquog, which enters the Merrimac on the northern boundary of the area in the city of Manchester, is not within the area surveyed, the drainage along the northern boundary being by brooks, though the South Branch of the Piscataquog flows through Francestown and New Boston, draining these and parts of adjacent towns. Pennichuck Brook lies between the Nashua and Souhegan rivers. It carries considerable water, and being dammed in a number of places in its lower course reservoirs are formed for supplying water to the city of Nashua. Besides the streams there are a number of small lakes and ponds, due chiefly to obstructed drainage, though many have been made artificially.

The streams have considerable fall in their courses, with numerous rapids or low falls, and afford a great amount of waterpower that has been utilized in the development of manufacturing industries.

The first inland settlement in New Hampshire is said to have been made in Hillsboro County by pioneers from Massachusetts, and though the exact date is not known it is thought to have been between 1665 and 1670 and at a point on Salmon Brook, in the town of Nashua. As grants were made the settlement of the county began to extend along the different streams. Later the Scotch-Irish began settling along the east bank of the Merrimac, especially in the town of Manchester, and in addition to these were some Irish direct from Ireland. There was some migration up the Connecticut Valley from

Connecticut, which extended into the southwestern part of the area. The older settlement near Nashua had increased to such an extent and had so satisfactorily fulfilled the conditions imposed for settlement that in 1673 it received a charter and was given the name of Dunstable. As incorporated it covered an area, it is said, of about 200 square miles, including a number of the towns at present adjacent to Nashua. At that time and for some time thereafter the general court of the province of Massachusetts had jurisdiction over this part of New Hampshire and all grants were made by the court.

In 1771, a century after settlement began, Hillsboro County was organized, with a population of 15,000. It then included a large part of what is now Merrimack County, and extended up the Merrimac River to the junction of the Pemigewasset and Winnipesaukee rivers. The population increased quite rapidly in the next fifty years, having almost quadrupled, but in 1823 Merrimack County was cut off and the census of 1830 showed a population of 37,724 for the present area of Hillsboro County. The population continued to increase, reaching 112,640 in 1900, and no doubt has increased since that time. There was during this time, however, a decrease taking place in the rural communities, the inhabitants moving to the manufacturing towns or moving out of the State entirely and taking up lands in the west. This decrease in some rural communities amounted to more than one-half, while the manufacturing towns grew rapidly in population. In more remote parts the number of permanent residents is still decreasing, the lands being held by new owners who live only a part of the year in the locality. The development of manufacturing made increasing demands upon labor and there has been a great influx of foreigners. Most of these are French-Canadians. There are many Greeks and Italians who work as unskilled laborers. Very few of the foreign classes take up farming, preferring mill work. During the summers the population is greatly augmented by summer boarders and tourists, who secure accommodations at the farmhouses and at the resort hotels in different parts of the county.

Within the Nashua area are located the two largest cities of the State, Manchester and Nashua, the former having a population of about 80,000 and the latter of 30,000. These are also the leading manufacturing centers of the State, made so by the fine water powers which they possess, the most important of which are those of the Amoskeag Falls of the Merrimac at Manchester and of the Nashua River at Nashua. The Souhegan affords a number of powers and at each place manufacturing towns have arisen, Merrimack at its mouth, Milford and Wilton some distance above, and Greenville on one of the forks of the Souhegan. Other towns and villages of some size in the area are Hudson, Hollis, Mount Vernon, Greenfield, and New Boston.

The transportation facilities of the Nashua area are exceptionally good. All the railroads belong to the Boston and Maine system. Its main lines run in the Merrimac Valley, reaching from Boston to the White Mountains and Canadian points. At Nashua, the most important railroad center of the State, a number of branch lines extend in different directions, and from Manchester other lines radiate to different points. No place within the area is very far from railroad facilities. These roads afford excellent service for tourist travel and also for delivering milk to the city of Boston. A number of electric lines connect the principal towns and cities in the Merrimac Valley with near-by cities in Massachusetts.

The county roads are numerous throughout the area and are kept generally in good repair. The roads leading to farms located on the tops of the hills are often steep, as little attempt has been made to follow easy grades. The older roads connecting settlements, however, were built more with reference to grades, especially the main stage routes. As the roads do not wash badly they are comparatively easy to keep in repair. The main highways are being macadamized.

The principal market for this section is Boston. The manufacturing cities and towns afford good local markets, and the demand is greater than the supply. Not only these places, but the summer boarding houses and the resort hotels depend upon the Boston market for their food supplies in excess of the local production.

Rural free mail delivery service reaches all parts of the area and rural telephone lines connect most farmhouses with the neighboring villages and cities. The educational facilities are exceptionally good.

CLIMATE.

The appended table, compiled from the records of the Weather Bureau station at Nashua, shows the mean, monthly, seasonal, and annual temperature and precipitation. Nashua is situated on the terrace at the junction of the Nashua and Merrimac valleys, in the southern part of the area, and only a few miles north of the Massachusetts line. The elevation of the station is about 40 or 50 feet above the river and about 150 feet above sea level.

The climate, as in temperate regions of this latitude, is marked by extremes of temperature. The absolute maximum recorded at Nashua is 100° F., and the lowest temperature —25° F., a range of 125° F. The winters are long and cold, with snow covering the ground to some depth a greater portion of the time. The mean winter temperature is shown to be several degrees below the freezing point. The summers are short and generally cool, although brief periods of extreme heat occur with high humidity. The mean temperature of the three summer months is 69° F. The mean annual precipitation

amounts to 43 inches and is fairly well distributed throughout the year. It ranges, however, from 29.4 inches for the driest year to 53 inches for the wettest year. The average annual snowfall amounts to 69.4 inches.

As Nashua is situated in a valley these figures represent, no doubt, the average condition of the valleys, but it is generally recognized that the valleys are much hotter in summer and colder in winter than the uplands. There is also considerable difference in the date of the occurrence of frost, sometimes amounting to several weeks, the last frosts of spring being later and the first of fall earlier in the lowlands and valleys. The growing season is generally long enough for most of the crops to reach maturity, though corn is sometimes caught by frost.

Normal monthly, seasonal, and annual temperature and precipitation at Nashua.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	28	64	−18	3.8	3.4	5.0	12.5
January	23	63	−25	3.9	2.8	2.6	17.2
February	25	60	−20	4.0	3.0	4.2	18.0
Winter	25			11.7	9.2	11.8	47.7
March	34	78	− 6	4.2	0.9	7.1	13.7
April	46	88	15	3.0	2.5	1.4	3.6
May	58	95	22	3.4	3.6	4.9	0.0
Spring	46			10.6	7.0	13.4	17.3
June	67	100	35	2.9	0.3	3.4	0.0
July	71	100	42	3.4	3.4	3.8	0.0
August	68	97	38	4.0	0.5	5.9	0.0
Summer	69			10.3	4.2	13.1	0.0
September	61	95	26	3.2	3.0	6.0	0.0
October	49	88	18	3.7	3.0	7.4	0.0
November	38	72	3	3.5	3.0	1.3	4.4
Fall	49			10.4	9.0	14.7	4.4
Year	47	100	−25	43.0	29.4	53.0	69.4

AGRICULTURE.

For more than a century after settlement began the agriculture of the area was little more than self-sustaining. Even as late as the Revolutionary war means of transportation were practically lacking, although gradually settlement had pushed its way to all parts of the area surveyed. The early products were corn, beans, pumpkins, squashes, melons, gourds, and tobacco. Later, potatoes and flax were

introduced, and by 1830, after the construction of turnpikes and canals, the cereals, rye, wheat, and oats, in the order named, became important products, while corn and hay assumed a position of importance which they have maintained to this day. Live stock, especially sheep, were raised largely at this period. Eighteen hundred and thirty marks the maximum point of rural population and agricultural production. The subsequent decline in both has been caused mainly by the remarkable development of manufacturing industries and to a less extent probably by the opening of the West. The latter influence is traceable plainly in the abandonment of cereal production, but the change to dairying has been brought about by other economic factors as well, chief of which is railroad transportation making it possible to market milk at considerable distances from the point of production.

The present agriculture consists of specialized farming in which dairying is the important feature, supplemented by fruit growing and poultry raising. Dairying is carried on entirely for milk production, though it passed through an earlier stage during which butter and cheese were more important products. All milk beyond that required for local consumption is shipped to Boston. Dairying forms at least a part of the interests on every farm. The soils are well adapted to dairying, as they support a good growth of grasses suitable for hay and pasturage. The price received for milk has in the past been low as compared with the retail prices obtained in the cities. Lately, prices have risen somewhat, though not in proportion, it is said, to the increased cost of feed, and the dairymen state that the profits are still small. They are, however, able to make something more than a bare living. In dairying, moreover, the farmer receives a part of his profits in the large quantities of manure made and the consequent ability to maintain or increase the productiveness of his land. It would seem practicable to install improved appliances in the farm dairies and to make butter, which brings a high price at present. This would be especially desirable for the more remote farms, from which the daily delivery of milk is troublesome. The system also has the advantage of retaining the most valuable feeding and fertilizing parts of the milk on the farm.

The crops grown are mainly those needed to supply the demands of the dairy, and consist of hay and corn, and a large proportion of the acreage of each farm is devoted to grass, the census of 1900 showing that in 1899 about one-half the improved land was in grass cut for hay. For the hay crop, a mixture of timothy, redtop, and clover are usually sowed. The average yield is about 1 ton to the acre.

There is considerable range in the yields, and where the mowing lands are top dressed with fertilizers or barnyard manure or both the yields are greatly increased. A common mistake is to keep the land

in grass so long that the crops obtained are quite small. Timothy is considered the most important of the grasses for hay. Clover does very well as far as the soils are concerned, but the climate seems to be too severe and the plants are often winterkilled. The millets and Hungarian grasses are quite generally grown in small patches on the farms as soiling crops, and seem valuable for this purpose. A volunteer grass (quitch grass) is cut for hay, but the yield is small. It usually crowds out the better cultivated grasses and is something of a pest. Wild grasses growing in the wet areas of Meadow also supply a part of the hay. The better areas, where at least partial drainage is practicable, make the heavier growth, but the hay is coarse.

Hay is supplemented by silage, many farms being equipped with silos. Corn is largely used for this purpose.

Corn for the grain is the most important of the cultivated crops. It is grown on every farm, and though the individual acreages are small the total production is considerable. High yields are secured by the generally intensive method of cultivation employed. The land is heavily fertilized with barnyard manure and in many cases with commercial fertilizers. Yields of more than 100 bushels to the acre are quite common, though the average is about 25 per cent less than this. An 8-rowed flint corn, having a very long ear, is grown. Not enough corn is produced to supply the feed needed for the dairy and other stock on the farms, though there is no apparent obstacle to increasing the acreage to a point where importations would become unnecessary.

Potatoes are a comparatively important crop, though not produced in commercial quantities to any extent. Each farm has its potato patch, which supplies the needs of the family, with a small surplus in some cases. In earlier days potatoes were a much more important crop, but the production has declined since 1870. Here is a product that might be given a larger acreage, as the soils will produce tubers of good quality and of fair average yields. The average yield now is about 100 bushels per acre, and could be increased by the potato specialist. Of the cereal crops only small patches are seen. The little wheat grown is used as poultry feed and is not thrashed. There is a growing tendency to produce more wheat. Rye and barley, the former a most important crop in the early part of the last century, are rarely grown now. Oats, too, once a staple crop, now occupy a very limited acreage, though the crop seems to be growing again in favor. The oat crop is usually cut for hay. A little buckwheat is grown. It would seem that this crop, which does well even on the upland soils, would be one of considerable profit in view of the limited areas in the county especially adapted to it and the good demand for the flour.

Beans were an important crop formerly, but their production has declined decidedly. The census of 1900 shows an acreage in 1899 of 280 acres, and there has probably been no increase in production during the past decade. Beans are well adapted to the local conditions of soil and climate. They yield, according to the authority just cited, about 10 bushels to the acre. The production of this crop could be profitably extended.

Flax, hemp, and hops were crops grown in 1840, hops being particularly an upland crop at that time. None of these are seen now, excepting an occasional hop vine in gardens.

Every farm has its vegetable garden, which rarely supplies more than enough for home needs. There are a few market gardeners in the area, who produce vegetables and small fruits for the local markets, though they do not satisfy the demand. The light sandy terrace soils are particularly well adapted to certain truck crops. There are also many small mucky areas in the Meadow that by draining could be profitably devoted to such crops as celery, onions, and cabbage. More attention should be given to producing vegetables to supply the manufacturing towns and the summer hotels and boarding houses of the area. As it is now, dependence is placed upon the Boston markets for supplies.

All the tree fruits are to be found on most farms, though the orchards as a rule are not extensive. There are a few commercial orchards in the area. Aside from these, little care is given the trees. The apple is by far the most important fruit. The red varieties are the most commonly grown, and of these the Baldwin leads, fully 90 per cent of the crop being of this variety. The Baldwin originated in Massachusetts just south of the New Hampshire line and in this section reaches perfection. The Northern Spy, McIntosh Red, and Rome Beauty are also common. Other varieties that succeed are the russets, Rhode Island Greening, and Gravenstein. The uplands afford the best sites for apple orchards. The conditions as regard frosts are most favorable in this section and the soils, especially the heavier phases, are adapted to their growth. North or northeast exposures are preferred. Apples are produced on the sandy soils of the valleys, but, though coloring well, they ripen earlier and do not keep so well as those grown in upland situations. Fruit growing in the valley is hazardous, on account of the more frequent unseasonable frosts. A large proportion of the lands of the area are suitable for apple orcharding, the stony character of the soil not being very objectionable. The production of apples could be greatly increased and would no doubt prove more profitable than the products at present shipped from the area. In fact, apple growing seems to offer the brightest outlook for the New England farmer.

Considerable quantities of peaches have been produced in past few years. The fruit is of excellent quality. A number of small commercial orchards are to be found, particularly in the southern part of the area. The climate is rather severe for the peach, yet the growers report that with present prices they have paid well. Some plums and pears are produced and do well. These fruits are not grown in a commercial way.

Strawberries do exceptionally well. Raspberries, both red and black, and blackberries grow wild in neglected spots. Blueberries and huckleberries are also abundant. There are a few cranberry bogs, but no particular effort is made to cultivate this crop.

Poultry is a source of considerable revenue. Poultry products form a part of the output of almost every farm and there are many who make poultry raising their main occupation. Egg production is the aim of most of the poulterers. Fresh eggs are always in demand at good prices. The cockerels hatched in keeping up the flocks are sold as broilers. The Rhode Island Red is the favorite breed and at present is raised almost to the exclusion of other sorts. Poultry raising is said to pay well under the special conditions found in the area, and could well be extended. The resort hotels still depend upon cold-storage fowls for their tables. It seems that this trade might be supplied locally. The great drawback in poultry raising is the high cost of feed. Most of the poultry raisers do not produce enough grain to carry their flocks, though where sufficient land is available there would seem to be no reason why this should not be done, and consequently they are beginning to grow small areas.

In the past forest products have been a source of no inconsiderable income. White pine was originally abundant and was removed by wasteful methods. In recent years interest has been taken in the reforestation of the rougher lands and now considerable bodies of this tree are found, some growths of merchantable size. Where pine has taken possession of the land it is held in high esteem and can not usually be bought. Stringent laws regarding fires are enforced, so that now comparatively little damage results from this cause. All the rougher lands should be reforested to white pine and systematic forestry methods employed, so that in time the lands now of least value will become perhaps the most valuable in the area. At present little system is shown in handling such areas. Allowing areas to reseed from old seed trees is about all that is done. No doubt plantings could be profitably made.

There are some valuable sugar forests in the area, and the farmers derive more or less income from the sale of sugar and sirup.

The cut-over lands are usually taken by white and yellow birch, which make a thick close growth. These trees grow rapidly and form the principal source of fuel. Hemlocks are numerous in the

rocky ravines and glens. They are of large size and valuable for lumber, pulp wood, and tan bark.

With a rather narrow range in agricultural products, the adaptation of soils to crops is not given much attention. All the crops of the region are grown on all the soils, though it is recognized that the loose, droughty sandy soils of the terraces are less desirable than the fine sandy soils on the terraces, the upland soils, or the first bottom soils. The Merrimac gravelly loam, though a leachy soil, is still in favor, as it is early and seems well adapted to corn and potatoes. The bottom soils are held in high esteem because of the large crops of corn and hay they produce. On the upland there is so little difference in texture and in yields that the question of selecting soils with regard to crops can not be considered. It is recognized that fruits, especially apples, do better on the tops and upper slopes of the hills, particularly those having a northern or northeastern exposure. The light sandy soils of the terraces are especially well adapted to market-garden crops.

The farms, particularly on the uplands, because of the large quantity of stone, must necessarily remain in grass, and rotation of crops on such areas is impracticable, but even on the cultivable areas a general scheme of rotation is not followed. For convenience the corn lot is usually located near the barns and often many crops in succession are removed, but this practice is compensated by heavy fertilization, large quantities of barnyard manure as well as commercial fertilizers being used, so that the productiveness of the fields does not decline as it would otherwise. Some take only two or three corn crops and then grow potatoes for one season and back to corn. Fields are often kept continuously in grass until the yields are no longer profitable. Better farmers make an effort to plow the land at least every five or six years and reseed, and this plan is attended with better results. Top-dressings of manure and commercial fertilizers are given by some and the yield is greatly increased in this way.

Whenever practicable a systematic rotation of crops should be followed, and the rotation scheme should include a leguminous crop. Clover does fairly well, though some difficulty is experienced in getting a satisfactory stand. Vetch and soy beans could be used where clover can not be grown.

Labor is very scarce and commands comparatively high wages. The younger men prefer to work in manufacturing plants. Some foreign laborers can be secured from time to time, but this class drifts into the mills and factories. During the haying season help is often so scarce that the hay harvest is delayed and much of the hay is not infrequently cut so late that its feeding value is materially reduced. The average size of the farm in Hillsboro County, according

to the census of 1900, is 109.8 acres, not differing much from the figures of 1850, when it was reported as 116 acres. In 1880 the average size was reported as 151 acres.

Nearly nine-tenths of the farms are operated by the owners and the leased farm is probably as rare as anywhere in the country. The summer resident farms are generally managed by a local superintendent, who remains on the farm throughout the year. It is difficult to estimate the value of lands in this section, so many factors enter into the matter. Bottom lands bring $100 or more an acre, while some of the sandy terrace soils have little value, unless they have exceptionally favorable locations or are forested with white pine. The uplands bring fancy prices near towns and along lakes or streams, where fine views can be obtained, but there the value is based upon esthetic factors rather than agricultural worth. In fact, the rougher and more stony it is the higher the prices paid. Farms at some distance from towns or railroads often do not bring the original cost of the buildings. It is notable that the farm houses are as a rule large and well built and the outbuildings and barns are good. All such buildings are painted and kept in good repair. In many houses the most modern improvements are found. Running water is piped into the barns as well as the houses, the water supply being usually a well or spring on the hill slope above the buildings. This general condition, which contrasts so strongly with farm improvements in many parts of the country, may be traced in part to the revenue derived from the summer-tourist trade. A part of the income of very many of the farms of the area comes from this source.

Nearly every farmhouse in the area has its telephone, connecting with the near-by villages and more distant points. The roads are kept in good repair. The State is constructing state highways by macadamizing the main arteries of travel, and much progress has been made upon roads in the Merrimac Valley. This is doing much to bring the tourists using automobiles to this part of the State. The farming class is fairly prosperous, though the conditions could be greatly improved, and the incomes from the farms quite naturally increased, even under the present conditions of labor. This could be brought about by a greater diversification of crops, so that the work would be more evenly distributed throughout the year. With an increased number of crops a systematic rotation could be practiced to advantage and the productiveness of the soils increased and maintained under the best conditions of soil management. Cereal production should be revived as one step to this end, and with the ruling high prices and the local demand for poultry feed these crops ought to give a fair margin of profit. Potatoes should be more extensively grown, as the soils produce this crop with profit. The rougher lands could be utilized in the production of spring lambs. The damage by

dogs could be eliminated largely by keeping the sheep in dog-proof shelter at night. These changes, with an extension of the present leading industries, dairying and poultry raising, and the less important but promising lines of fruit and truck growing, as well as other introductions which will suggest themselves to the farmers, would do much to advance the agriculture of the area.

SOILS.

The soils of the Nashua area consist of transported material of glacial origin and have been derived either from the mantle of glacial débris as originally laid down or as later modified by other agencies, principally water. Though the soils have been formed from foreign transported material, they are in great measure related to the underlying rock beds, since the materials have been derived from similar rock formations. The rocks underlying the State of New Hampshire are igneous and metamorphic crystallines of Pre-Cambrian age. They comprise a variety of granites, gneisses, and schists, and their derivatives through metamorphosis.

The granites predominate, and have entered so largely into the soil formation that the soils are commonly classed as granitic.

The process of formation of the soils from the original rocks of the region may be described as follows: During the glacial epoch all New England was covered by a moving sheet of ice of thickness sufficient to more than cover the highest mountain peaks. This great moving mass of ice scoured off the mountains, hills, and ridges, and filled the valleys with the débris. The ice by its great moving force and weight more or less crushed and pulverized these abraded materials, which, as the ice finally melted and receded to the north, were left upon the surface as a heterogenous mantle of coarse and fine materials. Material upon which the glacier rested was much compacted, and this is known as the ground moraine or lower till. The ice also carried within and upon it quantities of material which were dropped upon the surface, and this is known as the upper till. The latter is distinguished from the lower till by the general angularity of its bowlders and by differences in compactness and color. In the Nashua area the upper till does not seem to be prominent.

At the close of the glacial epoch the land subsided, and during the following, or Champlain, period the Merrimac Valley, and the other valleys to a less extent, were filled, as high at least as the highest terrace, by materials carried by the streams issuing from the melting ice front. By the varying velocities of the currents these materials were assorted and left in more or less well-defined layers. At the close of the Champlain, or terrace, period, there was evidently an elevation of the land, for the streams began cutting channels in

these deposits, working and redepositing the material and forming new flood plains and new terraces. This has continued until the streams have cut to the bed rock and flow over rocky floors. The last and lowest terraces or flood plains are at present in process of formation, though these are now relatively high and not entirely subjected to annual overflow. The Merrimac River in cutting its channel has changed its course often, so that the terraces are not continuous on one side or the other. In the larger tributary valleys indications point to an imponding of the waters and the forming of shallow lakes, in which course sediments were deposited in a horizontal position and since disturbed very little, if at all.

The soils, then, occurring in the Nashua area may be divided into two general groups—those derived from the drift as laid down or modified only by weathering and occurring upon the uplands, and those originating in the reworked materials or modified drift and forming the terrace soils. These two groups of soils, because of their different mode of formation and different topographic position, are placed in different soil series, and in each series a number of different types have been determined, upon differences in texture or other characteristics. Thus eight soil types, exclusive of Rough stony land and Meadow, were recognized and mapped, three of these occurring in the upland and five in the terraces. Two of the upland types are members of the Gloucester series, which has a wide distribution over New England and eastern New York. The other type associated with these has been given the local name "Hollis stony land." These types constitute only a small part of the uplands and represent the cultivable areas; glaciation left so many bowlders upon the surface that a large percentage of the land has to be classed as Rough stony land, a self-explanatory name used in the soil classification to denote a condition rather than a textural peculiarity. The areas mapped under this name are of no value except for forestry and grazing.

The Gloucester stony loam is the most widely distributed of the upland soils, though as a rule it is developed only in small areas. The Gloucester stony sandy loam represents the more sandy areas and is found largely along valleys where the surface material has been added to by wind-blown sands from the sandy river terraces. It may also represent the depositions of the less pulverized upper till, or it may be in places, as along valley slopes, lateral moraine deposits. Besides its more sandy texture it is distinguished from the Gloucester stony loam by the more general angularity of its bowlders.

The Hollis stony loam is closely associated with a belt of schist in the towns of Hollis and Nashua. The soil material is very

similar texturally to the general run of the upland soils, but is distinguished by the predominance of schist fragments and stones found in the soil and upon the surface. It appears to be largely of residual origin, though containing some glacial débris.

The soils on the terraces have been correlated with the Merrimac and Podunk series, which are found extensively along the streams of New England and eastern New York, the Merrimac representing reworked materials of granitic origin. Four types belonging in the Merrimac series are found in the area. The lowest terraces representing the recent flood plains of the streams have been mapped under the name of Podunk fine sandy loam, one of the most productive and valuable soil types in the area.

The areas of Meadow represent those places along streams and in depressions in the upland that are too wet to cultivate.

The names and actual and relative extent of the several types of soil are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough stony land	134,144	42.9	Merrimac sand	17,920	5.7
Merrimac gravelly sandy loam	49,536	15.9	Merrimac fine sandy loam	8,448	2.7
Gloucester stony loam	26,752	8.6	Hollis stony loam	7,040	2.3
Merrimac coarse sand	24,576	7.9	Podunk fine sandy loam	5,824	1.8
Gloucester stony sandy loam	19,712	6.3	Total	312,320	.....
Meadow	18,368	5.9			

GLOUCESTER STONY LOAM.

A profile section of the Gloucester stony loam would show it to be a heterogeneous mass of earthy material intermingled with gravel, stones, and bowlders and reaching to an unknown depth. The surface soil to an average depth of 8 inches consists of a light to dark brown, friable, fine-textured loam, or a slightly gritty or sandy to heavy sandy loam, often including considerable patches of coarser texture. Though the texture as a rule is inclined to be sandy, in some cases it is quite silty and heavy. The type usually contains a high percentage of organic matter, which imparts a dark color and a loaminess to the surface soil. This organic matter also renders the soil granular and friable, a noticeable characteristic of the type as a whole. The soil and the subsoil are more or less micaceous, the mica occurring generally as minutely divided particles, and giving a somewhat greasy feel to the soil material.

The subsoil extends to depths ranging from 12 to 24 inches, with an average of about 18 inches, and varies from a yellow to light-

brown sandy loam, becoming slightly coarser and more stony with depth. The color also changes in the lower depths to a light or bluish drab. The subsoil is generally compact, but when rubbed in the hand granulates and has the same friable characteristics as the soil. The lower subsoil, however, and the material below it is very compact and hard, and is locally spoken of as hardpan, though no cementing material is present and the close structure or compactness is due to great pressure of the ice sheet at the time of deposition. This underlying material is variable in character. In cuts it is seen in some places to be a compact bluish-drab coarse sand that readily falls apart, and in other places to be composed of finer particles of sand, with enough silt and clay to make it quite sticky.

Upon the surface of the type occur varying quantities of gravel, stones, and bowlders, sufficient to interfere more or less with cultivation. On cleared fields the stones and bowlders that could be removed have been used to build the field walls, the quantity being sufficient for the purpose. Rock fragments are also found scattered indiscriminately through the soil mass. They are all erratics, and were deposited as a part of the glacial débris. By the grinding action of the ice these stones fragments and bowlders were rounded or made subangular in shape. They consist of granite, gneiss, and schist, the granitic rocks predominating.

The Gloucester stony loam is found in all parts of the upland and generally occupies small elongated areas on the tops and slopes of the hills and ridges. Its surface is smooth as a rule and on the slopes it generally occupies the gentler and smoother areas. Lenticular or drumlinoid hills are a characteristic feature.

The position of this type insures good surface drainage, but the close impervious subsoil often causes cold wet areas and in these drains are desirable. Some drainage has been affected by what is known as "blind ditches."

The Gloucester stony loam is of glacial origin, being derived from glacial débris. This material making up the soil is known by geologists as the ground moraine or lower till. It was subjected to much grinding and pulverizing during the progress and recession of the ice sheet.

The Gloucester stony loam is the most important of the upland soils of the area. It is productive, and with fertilization, as is the general practice, produces fair yields of the crops grown. Aside from the stones and bowlders, it is a friable, easy soil to cultivate. Corn does especially well, giving yields of 50 or more bushels to the acre. With heavy applications of barnyard manure, supplemented by some phosphatic fertilizers, yields of 100 bushels or more are secured. The corn most commonly grown is an 8-rowed flint variety,

which produces a very long ear. Considerable ensilage corn is also grown, and some sweet corn for table use. Potatoes succeed on this soil, and it would seem advisable to increase the acreage. The cereal crops make a fair average yield, but are not grown to any considerable extent, oats holding first place. When wheat was grown yields of over 50 bushels to the acre were in some instances obtained. Owing to the compactness of the subsoil and the general fineness of the soil material, the type is very retentive of moisture, and this condition, as well as its texture, makes it a soil well adapted to grasses. A larger part of the type is devoted to grasses either for hay or for pasturage. Timothy, redtop, and clover are cut for hay and are generally sown together, but the timothy is considered the most important. As much as 3 tons of hay to the acre has been secured, but the average is about 1 ton. Clover seems to do well as far as soil is concerned, but winter-kills badly. The type supports a good pasture growth, especially if not left too long in sod without fertilization. Apples succeed well and the soil seems well adapted to them. Orchards are to be found on every farm, some of commercial size. The Baldwin is the favorite, but other varieties also succeed. The apples color well and are of excellent flavor and keeping quality. Fertilization of the orchards is practiced to get best results. A larger part of the type should be devoted to apple production.

The natural forest growth on this soil was fairly heavy, consisting of both evergreen and deciduous trees, the latter predominating. The sugar and other maples, elm, oak, and birch are the principal species. The rougher portions of the farms should be devoted to forestry, particularly in the growing of white pine.

The Gloucester stony loam constitutes the better class of farming lands in the county. As a rule, there are good, commodious dwellings and outbuildings on the farms and the fields are inclosed by stone walls. Farm values on this type can not be stated definitely, as so much depends upon improvements and location with reference to towns, water, etc. The farms, however, sell for reasonable prices, the lowest price being $10 to $15 an acre, including the rougher land.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Gloucester stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21507	Soil	5.6	12.4	8.4	22.0	11.7	29.5	10.0
21508	Subsoil	7.8	12.9	9.9	23.6	15.2	24.7	5.8

GLOUCESTER STONY SANDY LOAM.

The soil of the Gloucester stony sandy loam to a depth of 8 inches consists of light to dark brown, medium to fine sandy loam, underlain by yellow medium to fine light sandy loam or sand. In places the surface varies to a loamy sand, underlain by yellow sand of medium to fine texture and evidently consisting largely of wind-blown material from adjoining sand areas. The subsoil of the heavier phases is somewhat compact and differs little from that underlying the more sandy areas of the Gloucester stony loam, but as a whole it is distinguished from the subsoil of the latter type by a more silty and sandy texture and by the greater angularity of the included stones and bowlders. The stone content is usually greater than in the case of the Gloucester stony loam. The same erratic granite, gneiss, and schist occur; the last named predominates in some places. Generally the stones are so numerous that the soil auger can rarely penetrate to a greater depth than 20 inches. The soil and subsoil are somewhat micaceous as is the Gloucester stony loam, the mica occurring in finely divided flakes. Except for the stones and bowlders it is a light soil and easy to cultivate.

The type is found in different parts of the area as an upland soil associated with the Gloucester stony loam. Its most extensive occurrence is in the hills adjacent the Merrimac Valley. It occupies lower slopes next to sandy terrace soils, though found also on a number of hilltops and higher slopes. As a rule its surface is not so smooth as that of the Gloucester stony loam, being somewhat hummocky with large protruding angular to subangular bowlders.

The type has ready drainage and it is apt to be droughty, though some parts are fairly retentive of moisture, comparing favorably with the Gloucester stony loam in this respect. A general angularity of the rock fragments indicates that the areas of Gloucester stony sandy loam have not been so severely glaciated as the Gloucester stony loam. In part it appears to have been derived from the upper till, and where occurring on lower slopes it may represent remnants of lateral moraines. However, some parts seem to be merely the sandier portions of the lower till.

White pine seems to be very partial to the type, though the deciduous trees are also common. Cut-over areas spring up to birch. The larger part of the type is forested, though farms are seen that are apparently as productive as those on the Gloucester stony loam, and that many of the farms are less productive seems to be largely a matter of poor management. It produces with fertilization fair yields of the crops grown in this region. Grass does not make quite so close a sod on all of it as on the heavier soil, but fair hay crops are secured. Apples do well, though the orchards must be fertilized to make good growth and give really satisfactory yields. Some

peach orchards were seen on this type, and it seems well adapted to the production of this fruit.

The value of farms is about the same as in case of the Gloucester stony loam, the values depending upon location, improvements, and condition of the land. Areas having a good growth of white pine are not for sale.

The results of mechanical analyses of fine-earth samples of soil and subsoil of the Gloucester stony sandy loam are given in the following table:

Mechanical analyses of Gloucester stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21589	Soil	1.7	17.1	23.3	21.9	5.2	21.1	10.0
21590	Subsoil	.2	2.3	5.9	7.2	22.6	42.3	19.1

HOLLIS STONY LOAM.

The surface soil of the Hollis stony loam, to a depth of 6 to 8 inches, consists of a light-brown fine-textured loam. It contains considerable silt and clay and a relatively high percentage of the fine sands. There is also present some fine gravel, and both in the soil and upon the surface there is generally a large quantity of stone fragments, mostly slabby pieces of a schistose rock. On knolls these often form the larger part of the soil mass, there being only a small amount of fine interstitial material. Underlying ledges of rock in place are found close to the surface and even outcrop in some places. The fragments are as a rule only an inch or two in thickness and a few inches across, though some larger slabs occur. Where the land has been cleared these larger pieces have been removed to form the field walls. Only a few rounded granite bowlders are to be seen. There are in places some rounded gravel and cobbles of granite, and where they occur in considerable quantity the schist fragments are less prominent, in which case the type is very similar to the Gloucester stony loam. In some places the soil varies slightly, becoming a little more sandy textured or a light fine sandy loam.

The subsoil is similar in texture to the overlying soil, varying from a heavy loam to sandy loam, though, owing to the presence of less organic matter, it appears generally more sandy than the soil. The sand, as in the soil, is largely of the finer grades. When wet the subsoil is often somewhat sticky, the result of the clay and silt particles. Finely divided particles of mica are noticeable throughout the soil mass. In color the subsoil is a light yellow, which in lower depths becomes grayer, and in places it has a slightly brownish

cast. On knolls, where the material seems to be largely residual, the color is slightly reddish, reddish brown, or yellow. In places where the soil mass is of considerable depth and evidently largely glacial, at about 2 feet the underlying material is a gray or drab compact sand, a peculiarity often noticed in the other upland types. Scattered throughout the subsoil are found angular fragments and slabs of schist, together with some rounded fragments of other rocks. On account of the quantity of such fragments the soil auger can not penetrate usually below a depth of 20 inches.

The Hollis stony loam occurs in two bodies of considerable extent, lying largely in the town of Hollis and extending over into Nashua. These bodies are uninterrupted by other soil types and are only separated from each other by narrow Meadow and gravelly areas. The larger one extends from the Massachusetts line in a belt between 2 and 3 miles wide to a point 2 miles north of the village of Hollis. The other area occupies Pine Hill and the hills and slopes adjacent to it.

The Hollis stony loam is an upland type, the elevation of which ranges from 200 to nearly 500 feet. Its topography is distinct from that of the other upland types, being generally characterized by series of low knolls, knobs, and narrow ridges that result in a rather rough surface. In fact the formation with which this soil is associated gives rise largely to areas of Rough stony land. Glaciation, however, has smoothed the surface to some extent, so that areas occur in which there are no knolls or knobs, such a belt, though narrow, extending through the main belt in Hollis up through the village. The area on and about Pine Hill has been subjected to severer glaciation and the topography is less uneven and more like the usual glacial forms. All the Hollis stony loam is adapted to cultivation as far as topography is concerned.

The rock formation with which this soil is associated is a schist, which is tilted at various angles to the surface. Though it has been glaciated it appears that the soil material is not all transported material, but probably is in part residual, and derived in place or practically so from the underlying schist rock. The rock fragments were evidently not subjected to much grinding as they are still angular. The effect of glaciation was evidently to remove the preglacial soil mantle, leaving the bare rock ledges exposed which by subsequent weathering have broken down to some extent. Between the knobs on the smoothed areas, however, is found the more or less compacted glacial till with which are mingled the schist fragments.

The position of the type for the most part favors ready drainage from the surface and on the knolls water no doubt finds its way downward through the partings between the rock beds. The presence of a large number of small streams materially assist the drain-

age. Between the knolls, however, wet or Meadow areas are frequently found and in such places artificial drainage is necessary.

The smoother parts of the Hollis stony loam constitute some of the best farming land in the upland, and because of the type the town of Hollis is one of the most prominent agriculturally in this section of the State. Some of the best developed farms in the area are on this type of soil.

General farm crops are grown. Yields of over 100 bushels of ear corn to the acre are secured, though the average is considerably less than this. The soil is well adapted to grasses and good yields of hay are obtained. It has been found especially well suited to small fruits and orchard fruits. Strawberries and the other berries do well especially. A number of successful peach orchards were seen on this type. Apples of excellent color and flavor and of good size are produced, though on the whole they do not have so good keeping quality as those produced on the higher hills of the Gloucester stony loam. Barnyard manure and commercial fertilizer are applied in generous quantities to produce good crops. A large amount of barnyard manure is available as dairying is quite generally followed.

The farms on the Hollis stony loam, though some distance from railroads, have as high a value as the better farms of the Gloucester stony loam. In the vicinity of Hollis the farms seldom change hands.

The results of mechanical analyses of fine-earth samples of soil and subsoil of the Hollis stony loam are given in the following table:

Mechanical analyses of Hollis stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21505	Soil	0.0	0.3	0.9	38.9	10.2	21.8	27.5
21506	Subsoil	.1	1.4	2.0	18.4	14.2	27.0	36.7

ROUGH STONY LAND.

Rough stony land includes lands too rough and stony for cultivation, yet having enough soil between the rocks to support a forest growth or, when cleared, to afford some pasturage. Up to the time of settlement practically all the uplands could have been classed as Rough stony land, but other soil type names have been given to those upland areas that have since been fitted for cultivation by removing the stones and bowlders. Thus Rough stony land, as it has a general occurrence on the uplands, includes all the classes of soil materials that make the different soil types and represents a condition rather than textural differences of the interstitial earthy materials. The material is largely transported glacial débris.

The Rough stony land occupies the greater part of the county, its continuity being broken by the stream valleys and by the scattered cleared areas classed as other soil types. It occupies the tops and slopes of hills and ridges and the mountain areas. Occasional rocky knolls protruding through the glacial deposits in the valleys have been included, and some areas of outcropping ledges and precipitous bluffs not of sufficient size to map as Rock outcrop are mapped with the type. Such places as Rock Rimmon, in Manchester, and the bluffs and cliffs of Joe English Hill could more properly be designated as Rock outcrop.

Most of the Rough stony land is forested. Some parts support white pine entirely, in some the deciduous trees predominate, while in others the growth is a mixture of all. Chestnut, oak, elm, maple, and birch are the most common of the deciduous trees. In the rocky ravines hemlock, which attains a large size, is the predominant growth. The cleared areas if not given attention are soon occupied by ground hemlock or birch.

The value of Rough stony land is based mainly on its forest growth, and where this is white pine it is high, otherwise the value is low. Where this type of land is included in farms it is used for pasturage and to supply fuel.

The greater part of Rough stony land should remain in forest, and especially is it advisable to preserve the growth of white pine.

MERRIMAC GRAVELLY SANDY LOAM.

The first few inches of the Merrimac gravelly sandy loam consists of a light-brown light sandy loam. Below this it becomes more sandy and yellower. The soil ranges from 8 to 15 inches in depth and rests upon beds of gravel, in which there is a little rather coarse yellow sand. The gravel is rounded and varies in size from small pebbles to cobblestones. Upon the surface and in the soil there are varying quantities of the same rounded, waterworn rock fragments, the proportion being usually sufficient to give the type a decidedly gravelly character. Though the type as a whole may be classed as a light sandy loam, it varies to a sand or loamy sand.

The Merrimac gravelly sandy loam occurs as bands more or less disconnected in the narrow stream valleys at the foot of the upland slopes. Its topography consists of low small hummocky, gravelly knolls and hills and undulating terraces. The most of the type can be cultivated with very little difficulty. Its gravelly character and porous structure afford rapid and thorough drainage, and consequently the type as a rule is leachy and droughty.

The Merrimac gravelly sandy loam is formed from reworked glacial material deposited, as indicated by the coarseness of the materials, by swiftly flowing water. This took place at the close of the

glacial period when the ice was melting and large volumes of water were given off. In part, however, it may be morainal in origin. It supports a fairly heavy growth of pitch pine and white pine, and birch, oak, and some other deciduous trees. Much of it will also support a good stand of grasses.

The general farm crops of the area are grown on this soil, but as a rule it is not a desirable soil to cultivate, its leachy nature causing it to be subject to drought. Like all the soils with which it is associated, continued applications of fertilizers and manures are necessary in order to maintain fair crop yields. There are, however, some fairly good farms on this soil type. Being naturally well drained it is a warm and early soil, and where early crops are desired the soil affords some of the best areas in the survey. Where not too gravelly it would undoubtedly be suitable for truck crops. A large part of it is better for pasture and forest lands than for any other purpose.

MERRIMAC COARSE SAND.

The surface soil of the Merrimac coarse sand, to an average depth of 8 inches, consists of a yellowish coarse sand to dark-brown loamy sand, the latter areas resulting from larger organic matter content, especially of the upper few inches. The subsoil is a yellow coarse sand, generally coarser than the soil, which at an average depth of about 20 inches rests upon a stratum of small waterworn quartz gravel. Sometimes this gravelly stratum is found within a few inches of the surface and again it lies below 36 inches. Occasionally some rounded gravel is found on the surface, but nowhere in large quantities. Mechanical analyses of the soil material show this type to be composed largely of coarse sand, with considerable fine and some coarser gravel particles. It contains also medium and finer grades of sand, but very little silt and clay. Where the surface soil carries considerable organic matter the type is loamy and somewhat coherent, otherwise it is loose and incoherent. Owing to the coarse texture and loose structure it is an easy soil to cultivate.

The Merrimac coarse sand occurs along the larger streams in the area. It occupies what are known locally as "sand plains." The largest development is along the larger streams entering the Merrimac, extensive areas being mapped on lower courses of the Souhegan River, Pennichuck Brook, and Nashua River. Along the Merrimac itself only a few areas occur, these upon high flat terraces. The areas along the other streams are broad and flat with very slight changes in elevation. They usually lie from 20 to 40 feet above the streams, rising abruptly from the streams themselves or from the flood plains and extending back to the foot of the upland slopes. Though there are but few perceptible elevations, there are, however, depressions or

" pot holes " in which water has collected, forming small ponds generally circular in shape. The generally loose structure of the soil material permits the movement of water so rapidly through it that it is very leachy and droughty.

Washed glacial drift deposited in shallow moving waters has given rise to this type. This is evidenced by the level surface conditions and the coarseness of the material. As might be expected from its leachy and droughty nature, it is a very poor soil. Pitch pine is the predominating forest growth, and the prevalence of this tree has given the areas the local name " pine plains." Some scrub oak is also found, and in burned-over areas blueberry bushes and coarse grasses spring up.

A comparatively small area of the Merrimac coarse sand is cleared and under cultivation. The yields are as a rule low, and to produce even fair crops heavy fertilization is required. There are some areas where the underlying material is more compact, and on these it is possible to grow good crops. One of the best uses for this soil is truck growing, as it is a warm soil and easy to till. Its value as a trucking soil is, however, much lower than that of some of the other sandy terrace soils.

MERRIMAC SAND.

The Merrimac sand consists of 6 or 8 inches of medium-textured grayish to yellowish sand or loamy sand, underlain by similar material of yellowish color extending to a depth of several feet. In areas where there has been an accumulation of organic matter the color varies from light brown to dark brown and the soil is somewhat more loamy. In some places a small amount of rounded gravel is scattered through the soil, and gravel beds may be encountered at different depths within the soil profile. The type as a whole is loose and incoherent, and is readily blown by the wind, in some cases having been drifted higher than the upland slopes. Many bare, wind-blown spots are to be seen. The type becomes coherent only where enough organic matter has been incorporated to make it loamy.

The Merrimac sand is found almost entirely in the Merrimac Valley, its occurrence in other valleys being only in small areas. Its most extensive development is on the eastern side of the river, where it occurs as an almost continuous belt varying in width from less than one-fourth mile to more than 2 miles, the widest parts being in the towns of Litchfield and Manchester. On the western side of the valley the areas are scattering and not large. During the " terrace " period this soil formed the higher terraces of the Merrimac, but by a subsequent erosion and wind action the terraces have been largely obliterated. The greater part of the type is sloping

and even hilly, the winds piling up the sand toward the upland slopes and thus making the topography somewhat knobby. Some flat or gently rolling terraces occur, however, the largest being those on which the cities of Manchester and Nashua are situated. The elevations range from 20 to 200 feet above the Merrimac. The type being loose and incoherent, drainage is very rapid and its water-holding capacity is low.

The Merrimac sand is formed from the modified glacial drift. Material of this character largely filled the Merrimac Valley and still constitutes the larger part of the old terrace soils. Since the river has cut its way down through this material erosion by wind and water have been active.

Very little of the Merrimac sand is cleared and under cultivation. White pine seems to thrive on it and is one of the characteristic growths. On cut-over areas scrubby oaks, huckleberry and blueberry bushes, and coarse grasses spring up. Some pitch pine is found, as well as some deciduous trees, on the better parts. Where cultivated this soil is devoted mainly to corn and grass. In places, with fertilization, it gives moderate yields of corn. Large quantities of barnyard manure are used, supplemented by commercial fertilizers. It is not well adapted to grass, though it supports a light sod. Considerable areas of the type would be suitable for light truck crops to supply the local demand. The greater part of the type, however, should be devoted to forestry, and as white pine is indigenous its growths should be encouraged. Eventually this soil would yield a fair income from this source. Except where covered by white pine, in which case the land has a high value, the prices for land of this type of soil are low.

The results of mechanical analyses of the soil and subsoil of the Merrimac sand are given in the following table:

Mechanical analyses of Merrimac sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21446	Soil	0.9	11.8	21.2	53.3	6.6	2.2	3.6
21447	Subsoil	.6	15.6	23.1	51.0	6.6	.9	2.1

MERRIMAC FINE SANDY LOAM.

The Merrimac fine sandy loam is composed of a surface soil of brown fine to very fine sandy loam texture with a depth of 8 inches. Beneath this occurs a yellow fine sandy loam which usually grades into a yellow fine sand or loamy sand, extending to depths of 36

inches. The subsoil rests in places on a bed of gravel, but this rarely is found at less than 3 feet below the surface. This gravelly substratum occurs as a rule in the lower lying terraces. In general the subsoil is found to be more or less compact. Some variations in the type occur. In some places it is a fine sand, but this sand is, as a rule, coherent and only occasionally are bare, wind-blown spots to be seen. The surface soil contains generally a considerable amount of organic matter and this gives it the dark color and loamy texture.

The Merrimac fine sandy loam in this survey is limited to the Merrimac Valley, where it occurs in a series of narrow sloping terraces lying between the lower terraces or "intervales" of the river and the higher terraces or slopes occupied by coarser soil types. The areas are narrow and more or less continuous on both sides of the river.

The Merrimac fine sandy loam represents the finer particles of the glacial drift material deposited by the river as flood plains at an earlier period. The position is favorable to ready surface drainage. The internal drainage conditions, on the other hand, are better than in case of the coarser terrace soils and the type is quite retentive of moisture and of fertilizers.

Agriculturally the Merrimac fine sandy loam is the most important of the valley soils and gives the highest crop yields. It is adapted to grasses, which make a good, firm sod. Excellent yields of hay are secured as well as good pasturage. Corn and potatoes do particularly well. Apple trees make a thrifty growth and bear well. A part of the local truck growing is upon this soil, and it seems to be well adapted to this use. The land is all cleared and under cultivation. Grass for hay and pasturage is the leading crop and considerable dairying is done on the farms. As the main highways of the valley on both sides of the river follow, for most part, the higher and broader terraces of this type, much of the land is given up to residences and yards. The land is held in high esteem and has a higher value than any other in the survey. This is due in part to location and in part to its productiveness.

The results of mechanical analyses of the soil and subsoil of the Merrimac fine sandy loam are given in the following table:

Mechanical analyses of Merrimac fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21444	Soil	1.6	7.6	6.4	18.5	28.5	29.8	6.8
21445	Subsoil	1.3	7.0	5.5	20.5	37.7	23.2	4.5

PODUNK FINE SANDY LOAM.

The Podunk fine sandy loam, to a depth ranging from 6 to 12 inches, with an average of 8 inches, consists of a dark-brown fine to very fine sandy loam. The subsoil is a yellow fine sandy loam, grading in the lower depths into a loamy and usually somewhat compact fine sand or sand. In places gravelly layers are encountered in the subsoil at depths varying from 1 foot to more than 3 feet below the surface. Both the soil and subsoil are decidedly micaceous, the mica being in finely divided particles.

Some variations in the type occur. In places, particularly on the stream banks, the texture is a loose fine sand, and in troughlike depressions where water flows at high stages the soil is considerably more silty and clayey—a silty fine sandy loam, approaching a silt loam.

With the exception of the immediate stream banks the surface soil contains considerable organic matter, in some places enough to make the soil almost mucky. In fact, some very small areas of shallow mucky soil are included in the type, their extent not warranting separate mapping.

The Podunk fine sandy loam forms the "intervales" or bottoms along the streams. Its most important development is along the middle courses of the Merrimac and Souhegan rivers. A few narrow strips are occasionally found along some of the smaller streams. The areas are flat to gently undulating. Along the Merrimac the "intervales" are 10 to 20 feet or more above the river and only the lowest parts are subject to overflow; while on the Souhegan they lie near the stream bed, though above overflow, except in the troughs between the undulations.

The Podunk fine sandy loam has been built up of sediments laid down by the streams in present flood plains and is therefore of comparatively recent origin. Water passes readily through the soil and in these places it is somewhat leachy and droughty, though a bottom land type. On the other hand, the depressions are likely to be wet, especially in rainy seasons, as here the soil is usually heavier and more compact and the water does not drain off so readily. In these wet places drainage ditches are necessary.

The Podunk fine sandy loam is one of the most important soils in the area. It is especially adapted to grass and is used largely for growing this crop, furnishing good yields of hay and pasturage. It also yields fine crops of corn. Small grain crops grow very rank and lodge, and are seldom grown. When hops were produced in the county they did best on this type of soil. Potatoes, cabbage,

tomatoes, etc., do well and some small areas are devoted to their production.

As this soil is not overflowed regularly, it does not receive the addition of sediments usually so important in maintaining the productiveness of the alluvial soils, and it is found necessary to fertilize the crops grown in order to get the best yields. Barnyard manure and commercial fertilizers are used generously.

The farms on the Podunk fine sandy loam have a high value and none of the land is offered for sale.

The results of mechanical analysis of a typical sample of the soil and of the subsoil are given in the following table:

Mechanical analyses of Podunk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
21678	Soil	1.0	2.5	3.2	30.5	23.4	30.0	8.9
21679	Subsoil	.9	2.8	5.1	38.4	21.9	25.2	5.7

MEADOW.

Meadow includes those areas in their present condition too wet to cultivate lying around ponds and lakes and along stream courses. They are covered with water-loving grasses and support some bush and tree growth. The soil texture is variable, but is usually sandy, the upper stratum being made more or less loamy or mucky by an admixture of decayed organic matter. The subsoil may be a drab compact impervious sand or a clayey or silty material containing considerable quantities of sand. The subsoil is sometimes mottled yellow and drab. Some areas of Muck or Peat are found, but these were too small to map.

Though Meadow areas are distributed throughout the survey the total extent is small. In the uplands it is found as depressions and in the valleys as narrow bands along streams or around lakes and ponds. The drier parts support a heavy growth of coarse wild grasses which are cut for hay, and their value is based upon the yields and pasturage they afford. Some Meadow areas are drained by open ditches. The greater number could be drained only with difficulty and great expense, but if reclaimed would be valuable land not only for hay and pasturage but also for some vegetable crops. On the mucky soil celery, onions, and cabbage could be profitably produced.

The general value of Meadow land ranges from $5 to $10 an acre.

SUMMARY.

The Nashua area covers 488 square miles in Hillsboro County, which lies in the southeastern part of New Hampshire.

The surface varies from hilly and mountainous uplands, with a maximum elevation of 1,625 feet, to broad, deep valleys, in which a minimum elevation of 90 feet above sea level occurs. The drainage is through the Merrimac River and its tributaries.

The climate is rigorous in winter and pleasantly cool in summer. The mean annual temperature is 47° F. The mean annual precipitation is 43 inches.

The first settlement in inland New Hampshire was made in this area between 1665 and 1670. The rural population and agricultural production reached their maximum in 1830.

Marked changes have taken place in the type of agriculture. Corn and grass for hay and pasturage are the main crops to-day. These support a flourishing dairy industry, engaged in milk production for Boston and other large towns. Poultry raising for eggs is important. Some commercial apple and peach orchards are found, and there is a little market gardening. At an earlier period cereal production formed a salient part in the agriculture. Flax, hops, and tobacco were grown successfully at one time. These crops are adapted to conditions, and their culture could be revived.

Manufacturing absorbs the energy of a large part of the population, and has been the main cause of the decline in rural population and agriculture.

The area is well supplied with railroads. Summer tourists who flock to the region in the heated term add to the income of the farmers. The soils are of glacial origin.

Eight types, exclusive of Meadow and Rough stony land, were mapped.

The soils fall into two groups, the one composed of unmodified drift found in the uplands, the other of reworked glacial material found in the river bottoms and terraces.

Rough stony land occupies a large proportion of the upland. It affords some pasture, but is unsuited to cultivation. Its chief value is for forestry. The other upland soils are the Gloucester stony loam, Gloucester stony sandy loam, and Hollis stony loam. These types are all good grass and corn soils. Small grains will yield well. Apples and peaches are produced commercially to some extent. Fruit growing could well be extended over the area occupied by these soils.

The terrace soils belong in the Merrimac series, of which four members occur. The Merrimac sand, Merrimac coarse sand, and Merrimac gravelly sandy loam are more or less droughty. They are

used chiefly for general farm crops, and to a less extent for trucking. They are much better for market gardening than for corn and hay production.

The Merrimac fine sandy loam is the best type of the series. It is less droughty than the coarser members of the series. It gives satisfactory yields of hay and corn, but is by nature a truck and small fruit soil.

The bottom land type of the area is the Podunk fine sandy loam. This soil gives excellent yields of hay and is used largely for this crop.

All the soils of the area are given applications of barnyard manure and fertilizers. At present scarcity of labor limits farm operations. Much labor is attracted to the manufactories. Dairying and poultry raising should be continued along the lines at present followed. Fruit growing might well be extended, especially in the case of apples.

Sheep raising, for the purpose of supplying mutton and lambs, should be made profitable on the rough lands of the area.

Buckwheat, grown to some extent, might be made a profitable specialty. A better rotation of crops for soil improvement and for maintaining the hay lands and pastures in a more productive state is needed. To this end the culture of a number of crops once grown successfully in the area might well be taken up again.

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U.S. DEPT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

SOIL MAP

NEW HAMPSHIRE
NASHUA SHEET

SOIL PROFILE
(3 feet deep)

Merrimac gravelly sandy loam — Sl / Sl

Merrimac coarse sand — S / Cs / S&G

Merrimac sand — S / S

Merrimac fine sandy loam — Fsl / Fsl

Gloucester stony loam — L / Sl / Sl

Gloucester stony sandy loam — Fsl / Fsl

Hollis stony loam — L / Hl

Podunk fine sandy loam — Fsl / Fsl

LEGEND

S Sand
Cs Coarse sand
S&G Sand and gravel
Sl Sandy loam
Fsl Fine sandy loam
L Loam
Hl Heavy loam

LEGEND

Merrimac gravelly sandy loam — Mg
Merrimac coarse sand — Mc
Merrimac sand — Ms
Merrimac fine sandy loam — Ml
Gloucester stony loam — Gl
Gloucester stony sandy loam — Gs
Hollis stony loam — H
Podunk fine sandy loam — Ps
Rough stony land — R
Meadow — M
Swampy areas

Soils Surveyed by
Charles N. Mooney and W. C. Byers
1909

Scale 1/62500
1 0 1 2 3 Miles
1 0 1 2 3 4 5 Kilometers
Contour interval 20 feet.

Field Operations
Bureau of Soils
1909